R E P O R T R E S U M E S

ED 010 853 24

RELATIONSHIPS BETWEEN LEARNING AND SEMANTIC AND FORMAL SIMILARITY.

BY- BOHM, AUDREY M.
SAN FRANCISCO STATE COLL., CALIF.

REPORT NUMBER CRP-S-241 PUB DATE 66
EDRS PRICE MF-$0.09 HC-$1.16 29P.

DESCRIPTORS- LEARNING PROCESSES, SEMANTICS, VERBAL ABILITY, *ASSOCIATIVE LEARNING, *WORD RECOGNITION, *READING INSTRUCTION, *PAIRED ASSOCIATE LEARNING, *LEARNING THEORIES, PERCEPTION, PATTERNED RESPONSES, INSTRUCTIONAL MATERIALS, SAN FRANCISCO

AN EXPERIMENT WAS DESIGNED TO TEST THE HYPOTHESIS THAT, WITH MATERIAL OF HIGH MEANINGFULNESS, THE SEMANTIC DIMENSION OF SYNONYMITY (BATTLE-FIGHT) WILL HAVE GREATER IMPACT ON THE LEARNING PROCESS THAN THE DIMENSION OF FORMAL SIMILARITY (BATTLE-BOTTLE). THE LEARNING MATERIALS CONSISTED OF FOUR LISTS OF 12 PAIRS OF TWO-SYLLABLE WORDS. THEY WERE PRESENTED TO 120 SUBJECTS FROM INTRODUCTORY PSYCHOLOGY COURSES WHO WERE UNFAMILIAR WITH PAIRED-ASSOCIATE VERBAL LEARNING, AND THE EFFORT OF THE PAIR RELATIONSHIPS ON LEARNING WAS ANALYZED. THE MOST IMPORTANT FINDING WAS THE CONSISTENT FACILITATING EFFECT OF THE FORMAL RELATIONSHIP FOR BOTH FAMILIAR AND UNFAMILIAR MATERIALS. WITHIN THE CONTEXT OF THE CLASSROOM, THE FINDINGS INDICATED THAT CERTAIN LEARNING MATERIALS MIGHT BE LEARNED MORE EASILY IF A FORMAL RATHER THAN A MEANINGFUL RELATIONSHIP IS UTILIZED. (GD)

ED010853

NAA

Relationships Between Learning and Semantic and Formal Similarity

Cooperative Research Project No. S-241

Bohm

San Francisco State College

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

TITLE

Relationships Between Learning and Semantic and Formal Similarity

Cooperative Research Small Contract Project S-241

Author

Audrey M. Bohm
Associate Professor of Psychology
San Francisco State College
1600 Holloway Avenue
San Francisco, California 94132

Year

June 1, 1965 to May 31, 1966

The research reported herein was supported
by the Cooperative Research Program
of the Office of Education,
U.S. Department of Health, Education, and Welfare

TABLE OF CONTENTS

	Page
PROBLEM	1
RELATED RESEARCH AND RATIONALE	2
HYPOTHESES	5
PROCEDURE	6
Materials	6
Design	8
Method	8
Subjects	8
RESULTS	10
DISCUSSION	14
BIBLIOGRAPHY	19
APPENDIX	21

Illustrations

FIGURE 1	12

TABLES

Table 1	8
Table 2	16
Table A-1	22

PROBLEM

The importance of similarity as a variable influencing the learning process has been well established in the laboratory by many different investigators (Bugelski & Cadwallder, 1959; Gibson, 1941; Osgood, 1949). Similarity of the materials has been shown to affect rate of original learning, amount and direction of transfer as well as the degree of interference or retention. Many recent textbooks in the field of educational psychology make recommendations concerning teaching techniques on the basis of these findings, (Frandsen, 1961; Smith and Hudgins, 1964; Travers, 1963; Thompson, Gardner, and DiVesto, 1959).

Meaningfulness has been equally well established as an important variable influencing the learning process. The effect of increases in meaningfulness on the acquisition process has been demonstrated in numerous experiments which have used a variety of different indices of the concept. These indices include such measures as the percentage of subjects having associations (McGeogh, 1930), the number of associations given to a particular word (Noble, 1952), frequency of occurrence in the language, familiarity, and pronounceability (Underwood and Schulz, 1960). Again many recent texts in the field of educational psychology contain sections which are concerned with the influence of meaningfulness on learning and which suggest that teaching techniques be modified in the direction of the experimental findings. (Frandsen, 1961; McDonald, 1959; Sawry and Telford, 1958; Travers, 1963).

The purpose of the study presented here is to investigate the relationship between the degree of meaningfulness of the materials and the particular dimensions of similarity which have been traditionally

investigated in the laboratory. Most of these investigations have defined similarity in one of two ways, either in terms of the formal properties of the materials or situations or in terms of semantic properties. The former definition emphasizes the number of shared or repeated elements between two items, e.g., battle-bottle, while the latter emphasizes the semantic dimension of synonymity, e.g., battle-fight. In the past investigators have proceeded as if these were mutually exclusive instead of overlapping categories. With nonsense material where the cognitive aspects of the material are minimal there is little probability of confounding the effects of semantic and formal similarity. However, with meaningful material, such as the verbal materials used in classroom instruction, the possibility of a confounding effect is much greater. Specifically, this experiment is designed to test the hypotheses that with material of high meaningfulness the semantic dimension of synonymity will have a greater impact on the learning process than the dimension of formal similarity. Conversely, with material of low meaningfulness, it is expected that the formal dimension will have a greater effect than the semantic.

RELATED RESEARCH AND RATIONALE

The rationale for the above hypotheses is derived from an associative theory of learning. Such a theory views the learning of verbal material as subject to the influence of prior associative experiences. In the laboratory setting these earlier experiences have been designated as pre-experimental habits (Underwood & Postman, 1960). Depending on the specific learning situation (paradigm) involved, these pre-experimental habits have been shown to act positively to facilitate the learning of new material, negatively as interfering competitors

with new associations or positively and negatively simultaneously to produce both facilitation and interferences (Postman, 1962, 1963). The theory also assumes that as the familiarity of the materials increases so too does the number of these pre-experimental habits. It therefore follows that unfamiliar materials should be less influenced by pre-experimental habits while familiar material should be more influenced.

The present experiment stresses an additional assumption that the effects of pre-experimental habits do not occur at random but rather that they are mediated by categories. This assumption emphasizes the point that interference and/or facilitation occurs along certain specific dimensions.

One of the most important and well investigated dimensions along which these effects occur is similarity of the materials. Numerous experiments have investigated similarity as a parameter in both learning and retention. When these investigations have dealt with nonsense material the traditional definition of similarity has been in terms of the number of identical elements or repeated letters. When meaningful words have provided the material for the experiments similarity has usually been manipulated in terms of the semantic properties of a word. Thus, the concept of similarity has been explored by investigators using two different definitions neither of which excludes the other. The definition in terms of identical elements is essentially a formal one based on the physical characteristics of the material. The semantic definition might be termed a cognitive definition since it is based on the meaningful properties of the items. What should be noted is the fact that these definitions are not mutually exclusive. Objects of

any kind have both form and meaning, and this is particularly true of verbal materials. The most meaningful word is composed of the formal properties of its letters while even the least meaningful nonsense syllable may elicit some kind of meaningful association. To date there has been no direct attempt to evaluate separately the effects of these two dimensions of similarity.

Certain evidence suggested that each of these dimensions may influence the learning and retention of verbal materials to a different degree depending on the frequency of the words. When both high and low frequency words were given as stimuli in an association test many more formal responses were given to the low words than to the high words (Postman, in press). While conducting a series of experiments at the University of California at Berkeley under the direction of Leo Postman, the author noted that different aspects or properties of the material were selected and utilized by subjects learning and remembering low frequency material than were selected by subjects who were dealing with high frequency items. During the free recall of low frequency words subjects tended to alphabetize and group together physically similar words. During the free recall of high frequency words the items tended to be grouped in meaningful sequences with little attention to their formal properties. These observations suggested that when the familiarity of the items is low and the exact cognitive meaning of many of the words may be unknown to many subjects, the formal properties of the material would be emphasized. With familiar materials knowledge of the cognitive meaning of the items is more probable and within this richer associative context the importance of the formal properties of the items should diminish.

HYPOTHESES

The present experiment was designed to test the hypotheses that for unfamiliar stimulus words formally related responses could be learned more readily than semantically related responses. With familiar stimulus words the semantic relationship was expected to be more effective than the formal.

PROCEDURE

Material.

The learning materials consisted of four lists of twelve pairs of two syllable words. Two sets of twelve stimulus words were chosen from the association norms of Postman (in press). One set of high frequency (Thorndike and Lorge, TL, 1944) stimuli (HS) had a mean frequency of 489 with a range from 151 to 1564. A second set of low frequency stimuli (LS) had a mean frequency of 14 with a range from 1 to 32. The choice of specific stimuli was based on the occurrence of appropriate response terms in the nouns.

Two types of response terms were selected from the association nouns for eight of the HS and eight of the LS stimuli. One set of responses was selected on the basis of their formal (F) similarity to the stimuli. Formal similarity was defined as the percentage of letters in the response word also occuring in the stimulus word, e.g., Trouble-Turtle 100%, Bramble-Gamble 84%. The mean percent of formal similarity between stimuli and responses was 85%.for the HS pairs and 73% for the LS pairs. The second set of responses was selected on the basis of their semantic (S) relationship to the stimulus word, e.g., Trouble-Anguish, Bramble-Thistle. The existence of a semantic relationship was established by noting the occurence of the response word as a synonym for the stimulus word in recognized sources (e.g., Roget, 1962; Webster, 1942, Fernald, 1947.) The mean percentage of formal similarity between stimuli and semantic responses was 27% for HS pairs and 18% for LS pairs. For the HS pairs the mean association value (Postman, 1966) was 2.50 for (F) pairs and 1.63 for (S) pairs. For the LS pairs the mean association value was 3.25 for (F) pairs and

2.75 for (S) pairs.

The four remaining stimulus words within each frequency were paired with unrelated words (U), i.e., words which did not occur as associates or as synonyms and which had minimal formal similarity, e.g., Window-Human, Fetish-Quarter. The mean percentage of formal similarity was 25% for HS pairs and 28% for LS pairs. The unrelated pairs were included to minimize the effect of a specific response set to give either synonyms or formal responses or more general set to give associations.

Two different lists, A & B, were constructed for each HS and LS frequency, each list containing four F pairs, four S pairs and four U pairs. For a given stimulus frequency the stimuli were the same in each list while the response terms for F or S pairs were either one or the other, i.e., the formal or the semantic response. For the U pairs the responses in each list were different unrelated words. The TL frequency of all responses was balanced between lists and among pair relationships so that an equal number of high and low responses appeared in each condition. All high responses were TL count A or AA. Low responses ranged from 8 per 18 million to 19. A complete description of the lists can be found in the Appendix.

This selection and frequency control procedure exhausted the available pairs of words in the norms. It was therefore necessary to include some pairs in which the response terms also occured as associatives to stimuli other than the one to which they were paired. The occurence of all such inter-item associations was noted and will be incorporated in the discussion of the results.

Design.

One half of the subjects learned lists with high stimulus frequency, the other half learned lists with low stimulus frequency. Paired relationships were manipulated within lists as were response frequencies. The design of the experiment is thus mixed with independent comparisons between stimulus frequencies and repeated measures among pair relationships and response frequencies. The design is summarized in the following table:

Table 1. Experimental Design

Pair Relationship	Response Frequency	STIMULUS FREQUENCY	
		Hi S	Lo S
F	H		
	L		
S	H		
	L		
U	H		
	L		

Method.

The lists were presented on a Stowe electronic memory drum at a 2:2 sec rate with an 8 sec intertrial interval. To minimize the effect of the serial learning of response terms instead of stimulus response pairs five different orders were constructed for each list. The orders were random with the restriction that no pair appeared more than once in the same serial position nor was any pair followed by another pair more than once. Each S continued learning the lists until a criterion of 12/12 was reached on a given trial.

Subjects.

There were 60 Ss in each group making a total of 120 in the experiment. Ss were volunteers from introductory psychology courses and were naive to paired-associated verbal learning. Assignment to conditions was by the randomized black technique. Each S was paid $1.25 for his

participation in the experiment. Eight pilot Ss were run to determine the general level of difficulty of the tests. A total of four S were rejected, 2 HS and 2 LS. Two were experimenter errors and two were failures to learn, 1 HS and 1 LS. The total number of S's involved in the research was thus 132.

In the original proposal it was expected that observations could also be made of transfer to a second list and of retroactive interference, i.e., the retention of the first list. In the process of constructing the lists it was discovered that these aims could not be accomplished because of the limited number of appropriate pairs of words available in the norms. A particular problem was the presence of inter-item associations among the responses. A full discussion of this problem will be found in the results section. This problem was partially solved by having subjects learn a single list only; however, this solution precluded the learning of any further lists, and, consequently, any tests of transfer or retroaction. Since the main problem with which the research was concerned was the effect of the pair relationships on learning it was decided that it was appropriate to limit the study to the observation of original learning only.

RESULTS

Within each stimulus condition a t test was performed between the mean total number of correct responses on List A and List B. For the HS group t = .76, $p > .05$ and for the LS group t = 1.13, $p > .05$. Since neither t value approached significance both lists were grouped for the first analysis.

The mean number of correct responses for lists A and B during learning for each condition is presented in Fig. 1 and in Appendix Table 1. Each value represents the mean of the sum of two pairs of items. Thus the value 17.5 for the point LS - HR - F is the mean of the sum of two such pairs. The mean value for any single pair at any point is simply the value at that point divided by two. It should be noted that in Fig. 1 slower learning between groups is indicated by a greater total number of correct responses in the slower group while slower learning within a group is indicated by a fewer number of correct responses in the slower condition.

An analysis of variance for a mixed design for fixed variables with one independent and two repeated measures was performed on the scores (Winer, 1962). The results of the analysis (Appendix A-1)) indicates that all main effects and interactions are significant beyond the .05 or .01 percent level.

The greater total number of correct responses made by the HS group as compared with the LS group, F = 5.29, $p < .05$, reflects the slower learning and greater difficulty of the LS material. The effect of response frequency is also significant, F = 18.67, $p < .01$, demonstrating the slower learning of LR responses within a list. However, a significant interaction between stimulus and response

frequency suggests that this difference in learning is a function of the LS condition only.

The effect of pair relationships is highly significant, $F = 134.54$, $p < .01$. In all cases the F condition is superior to the S and U conditions. With the exception of the HS - HR condition the negative progression from F to S to U is consistent. At no point is semantic similarity superior to formal similarity. These results confirm the prediction for LS material but directly contradict the prediction for HS material.

The significant interactions between pair relationships and both stimulus frequency and response frequency as well as the significant triple interaction draw attention to the HS - HR condition. Here the F - S - R progression is disrupted and the S condition appears to be poorer than the U. An analysis of the errors made during learnings showed that this effect was mainly determined by the interference of two pairs of items in a single list. A check of the association norms also showed that the two pairs were related associatively. It therefore appears that the poorer performance on the semantic pairs in this group is a function of inter-item association in a single list, List B, and not a reflection of the interaction of manipulated variables in the experiment.

It was therefore decided to confine the remainder of the analysis to a single list for each condition, List A. This resulted in dropping the total N from 120 to 60. The selection of List A for the LS condition was made by chance and was decided upon prior to any examination of the separate lists in this condition other than the original t test.

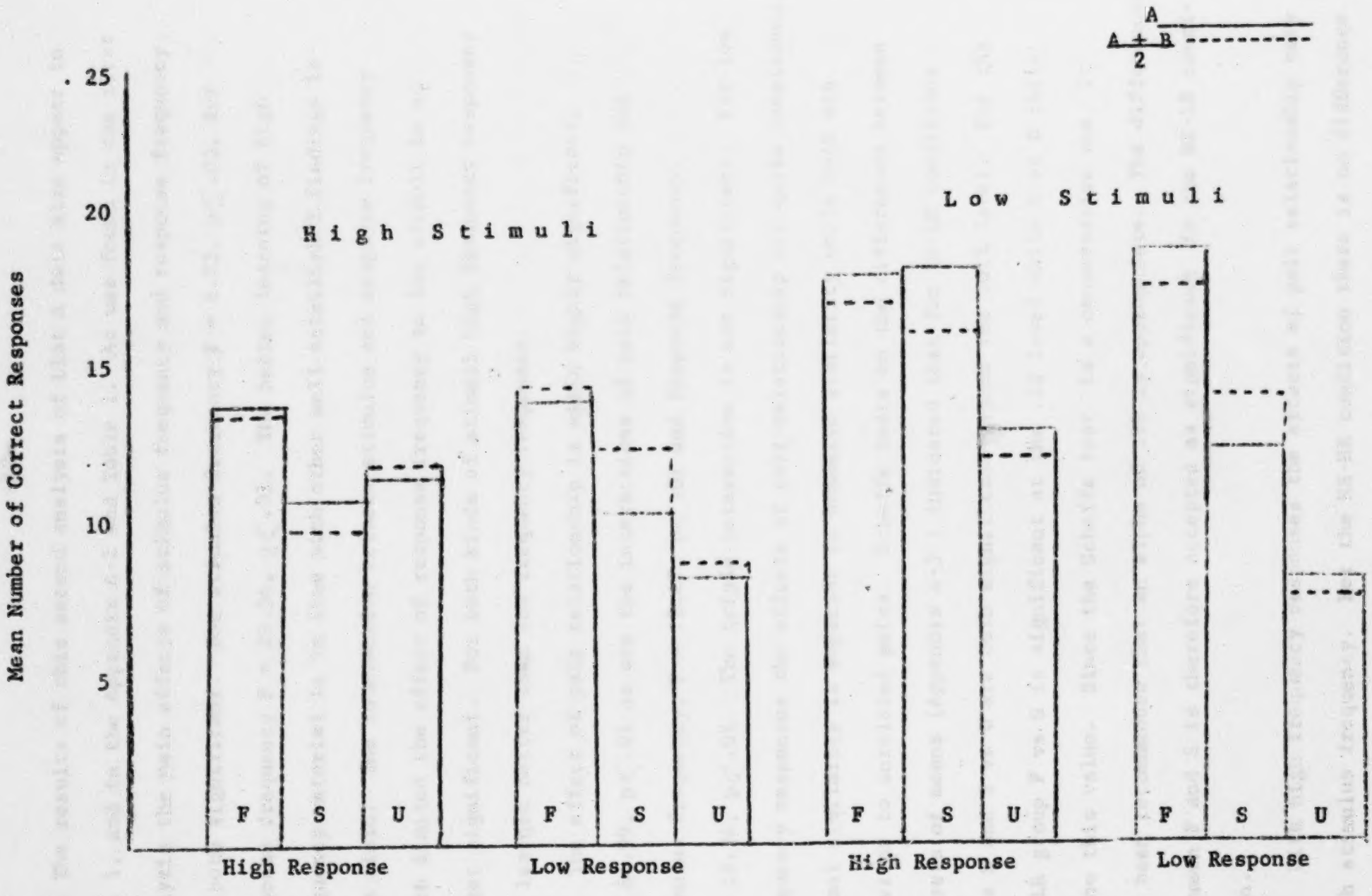

Fig. 1. Mean number of correct responses for high and low stimuli, high and low responses and F-S-U pair relationships for lists A and B combined and list B alone.

The results of this second analysis of List A data also appear in Fig. 1, and in the Appendix A-2 and Table 1. As was found in the first analysis the main effects of stimulus frequency and response frequency are both significant. For stimulus frequency $F = 6.73$, $p < .05$, for response frequency $F = 29.36$, $p < .01$. The better learning of high frequency material is in line with other well established findings in this field. The interaction between stimulus and response frequency which limited the effect of response frequency to low stimuli is no longer significant. For both kinds of stimuli high frequency responses are learned better than low frequency responses.

The effect of pair relationship is again highly significant, $F = 64.99$, $p < .01$ as are the interactions of pair relationship and stimulus frequency, $F = 12.47$, $p < .01$ and response frequency, $F = 18.74$, $p < .01$. The triple interaction is not significant. For low frequency responses the effects of pair-relationship are quite consistent, formal similarity is superior to semantic similarity while both are superior to unrelated pairs. Scheffe tests on the differences between subsets of means (Appendix A-3) indicated that for LS-LR conditions F vs S and S vs U are both significant beyond the .01% level. For the HS-LR group F vs S is significant at the .10 level while S vs U falls below this value. Since the Scheffe test is a conservative one, it has been recommended that an alpha of .10 is appropriate. The differences between F and S is therefore accepted as significant in the HS-LR condition.

With high frequency responses the effects of pair relationship vary with stimulus frequency. For the HS-HR condition there is no difference between S and U while F is significantly different from both at the .10 level. In the LS-HR condition there is no difference between F and S

while both are significantly different from U at the .01 level.

If stimulus and response frequency conditions are viewed as varying in terms of the difficulty of the material to be learned, from easy to hard in the following progression, HS-HR, HS-LR, LS-HR, LS-LR, the effects of pair relationship may be summarized as follows. With very easy materials, HS-HR, semantic pairs are learned no better than unrelated pairs while formal pairs are learned better than both. As the material becomes slightly more difficult, HS-LR, the disadvantage of unrelatedness becomes more apparent. With an additional increase in difficulty, LS-HR, both formal and semantic relationships facilitate the learning of the material as compared with unrelatedness. In the most difficult condition, LS-LR, the formal relationship facilitates learning more than the semantic which in turn is more facilitating than the absence of a relationship.

CONCLUSIONS AND IMPLICATIONS.

The single most important finding of the experiment is the consistent facilitating effect of the formal relationship for both familiar and unfamiliar materials. In the original hypotheses this result was expected for the unfamiliar, low frequency pairs, but was not predicted for familiar pairs, where the semantic relationship was expected to be the more effective.

The significant effects of stimulus and response frequency may be attributed to a general facilitating effect due to the amount of past experience with the materials. Familiar words are better integrated items and more readily available to the subject than are unfamiliar words. Unfamiliar words are less recognizable and may even have to be integrated before they can be produced as learned items. Thus, the finding that high frequency stimuli and responses produce better learning than low frequency items is consistent with associative theory and other empirical findings in the area.

However, additional theoretical assumptions are required to explain the results concerning pair relationships. These results may be summarized as follows:

1) When stimuli and responses are both familiar, (H-H) there is no difference between semantic (S) and unrelated (U) pairs while formal (F) pairs are superior to both.

2) When stimuli are unfamiliar and responses are familiar (L-H), F and S are equal and both are superior to U.

3) When stimuli are familiar and responses are unfamiliar (H-L), F is better than S which is better than U.

4) When stimuli and responses are both unfamiliar (L-L), F is better than S which is better than U. These results are presented

symbolically in Table 2.

It is felt that these results can best be explained by the introduction of the concept of mediation. This concept refers to an internal event which is assumed to occur and facilitate the learning of an S-R association. Underwood (1965) has suggested that two different types of mediators may occur. The first type is called a representation response (r.r.) and consists of some internal representation of the stimulus itself. This type of mediator might also be described as perceptual. The second type of mediator is called an implicit associational response (i.a.r.) and involves the arousal of the meaningful or cognitive aspects of a stimulus. In the context of the present experiment it is suggested that the introduction of a pair relationship is equivalent to activating a mediator. In the case of formal similarity the mediator is assumed to be a r.r. or perceptual type response. With the introduction of a semantic relationship it is assumed that the implicit associational response, i.a.r., comes into play. In the presence of familiar material the r.r. or the i.a.r. are equally effective as mediators. With unfamiliar material the absence of a rich associative context makes the i.a.r. less effective than the r.r. No mediation is assumed to occur with unrelated pairs. Columns 3 and 4 in Table 2 summarize these assumptions.

One final set of assumptions is needed to complete the explanation. Since the i.a.r. involves the associative properties of the word, it will be argued that the activating of this mediator not only facilitates the forming of an association, but also presents the opportunity for interfering responses from the i.a.r. complex to occur and impede learning.

Table 2. Summary of pair relationship results and their theoretical explanation.

1 Condition	2 Result	3 Mediator	4 Wt.	5 Interference	6 Med. & Int.
H-H	F > U=U	F rr	2	0	2
		S iar	2	-2	0
		U -	0	0	0
L-H	F=S > U	F rr	2	0	2
		S iar	2	0	2
		U -	0	0	0
H-L	F > S > U	F rr	2	0	2
		S iar	2	-1	1
		U -	0	0	0
L-L	F > S > U	F rr	2	0	2
		S iar	1	0	1
		U -	0	0	0

This interfering potential is dependent on the presence of familiar stimuli and enhanced when both stimuli and responses are familiar. In Table 2 this is represented by the minus values in column 5. A simple sum of the weighted mediator and amount of interference in the final column (6) describes the rank order of the pair relationship findings.

For the H-H group the advantage of S mediation is offset by a high degree of interference depressing performance on S pairs to the level of the U pairs. In the L-H group the absence of such interference leaves F and S equally effective. In the H-L condition the S effectiveness is modified by a moderate amount of interference. In the L-L condition the absence of interference is offset by the ineffectiveness of the semantic or iar mediator. These findings have implications for continuing research in both the laboratory and the classroom.

Within the laboratory context a further exploration of the effectiveness of formal similarity as a mediator is suggested. Mediation can be defined operationally in terms of an experimental design and the formal, semantic relationship should be investigated in terms of explicit rather than implied mediation, i.e., as an empirical fact rather than a theoretical construct.

The assumption of minimal interference for rr mediation might be substantiated by free association techniques.

Minimally the findings should be replicated with different materials and techniques to extend their generality.

Within the context of the classroom these findings are related to the general emphasis which is usually placed on "meaningful" relationships among materials to be learned. Since these results indicated a high degree of facilitation in learning with a formal relationship it is possible that certain learning materials might be learned more easily if a formal rather than a meaningful relationship was utilized, e.g., the BOY plays with a TOY instead of the BOY plays with a GIRL.

Another possible implication of the finding is that children with reading difficulties may be emphasizing formal properties and rejecting a move to the more difficult semantic aspects of the materials. The equal effectiveness of semantic and formal relationships in the LS-HR group suggests a possible way of correcting the "set" for formal properties if it exists.

If would also seem appropriate to investigate the developmental aspects of the phenomena. The early learning of nursery rhymes can

be seen as a related phenomena either as an antecedent or consequent of a preference for the formal relationships.

The phenomena may also be of value in suggesting ways of introducing new material in the curriculum. It is possible that a combination of meaningful with formal would prove most efficient for certain kinds of material, e.g., BOY-TOY rather than BOY-GIRL.

BIBLIOGRAPHY

1. Bugelski, B.R. and Cadwallder, T.C., "A Reappraisal of the Transfer and Retroaction Surface," J. Exp. Psychol., 1959, 52, 360-370.

2. Fernald, James C., Funk and Wagnalls Standard Handbook of Synonyms, Antonyms, and Prepositions. (New York, Funk & Wagnalls, 1947).

3. Frandsen, Arden N., Educational Psychology. (New York, McGraw-Hill Inc., 1961) p. 361.

4. Gibson, E.J., "Retroactive Inhibition as a Function of the Degree of Generalization between Tasks," J. Exp. Psychol., 1941, 28, 93-115.

5. McDonald, Frederick J., Educational Psychology. (Belmont, Calif., Wadsworth Publishing Co., Inc., 1959).

6. McGeoch, J.A., "The Influence of Associative Value upon the Difficulty of Nonsense-Syllable Lists," J. Genet. Psychol.,1930, 37, 421-426.

7. Noble, C.E., "An Analysis of Meaning," Psychol. Rev., 1952, A 59, 421-430.

8. Osgood, C.E., "The Similarity Paradox in Human Learning," Psychol. Rev., 1949, 56, 132-143.

9. Postman, Leo, "The Effects of Language Habits on the Acquisition and Retention of Verbal Associations," J. Exp. Psychol., 1962, 64, 7-19.

10. Postman, Leo, "Does Interference Theory Predict Too Much Forgetting?" J. Verbal Learn. Verbal Behav., 1963, 2, 40-48.

11. Postman, Leo, in press association norms for four frequencies of Thorndike-Lorge words.

12. Roget's International Thesaurus. (New York, T.Y. Cromwell, 1962).

13. Sawrey, J.M., and Telford, C.W., Educational Psychology. (Boston, Allyn and Bacon, Inc., 1958).

14. Smith, Louis M., and Hudgins, Bryce B., Educational Psychology. (New York, Alfred A. Knopf, 1964) p. 359.

15. Thompson, G.G., Gardner, E.F., and DiVesta, I.J., Educational Psychology. (New York, Appleton Century Crofts, Inc., 1959).

16. Thorndike, E.L., and Lorge, I., The Teacher's Word Book of 30,000 Words. (New York, Bureau of Publications, Teachers Coll., Columbia Univ., 1944).

17. Travers, Robert M.W., Essentials of Learning. New York, The MacMillin Co., 1963. pp. 190-201.

18. Underwood, B.J., and Schulz, R.W., Meaningfulness and Verbal Learning. New York, Lippincott, 1960.

19. Underwood, B.J., Vice-presidential address, American Association for the Advancement of Science, Berkeley, December, 1965.

20. Webster's Dictionary of Synonyms. Springfield, Mass., G. & C. Merriam Co., 1942.

21. Winer, B. J., Statistical Principles in Experimental Design. New York: McGraw-Hill, 1962.

A P P E N D I X

Analysis of Variance of the Number of Correct Responses for Lists A and B and for List A Alone.

	A-1 List A & B			A-2 List A		
Source of Variation	df	MS	F	df	MS	F
Between Subjects	119			59		
A (Stim. freq.)	1	970.69	5.29*	1	1,303.40	
Subj. w. groups	118	183.33		58	193.53	6.73*
Within Subjects	600			300		
B (Pair relatnshp.)	2	1,771.88	134.54**	2	1,065.91	64.99**
AB	2	433.77	32.94**	2	204.55	12.47**
B x subj. w. groups	236	13.17		116	16.40	
C (Resp. freq.)	1	190.14	18.67**	1	275.62	29.86**
AC	1	136.94	13.36**	1	35.48	3.84
C x subj. w. groups	118	10.25		58	9.23	
BC	2	476.80	37.13**	2	152.57	18.74**
ABC	2	73.04	5.68*	2	37.39	4.59
BC x subj. w. groups	236	12.84		116	8.14	

Scheffe tests on subsets of means.

Comparison		F
HS-HR	S vs. U	.44
HS-HR	F vs. S + U	6.78***
HS-LR	F vs. S	8.65***
HS-LR	S vs. U	3.00
HS-F	HR vs. LR	.01
HS-S	HR vs. LR	.06
HS-U	HR vs. LR	6.97***
LS-HR	F vs. S	.01
LS-HR	F + S vs. U	24.21**
LS-LR	F vs. S	15.46**
LS-LR	S vs. U	24.22**
LS-F	HR vs. LR	.87
LS-S	HR vs. LR	9.65***
LS-U	HR vs. LR	13.78*

* $p < .05$ ** $p < .01$ *** $p < .10$

TABLE A-1

Mean Number of Correct Responses in Learning.

Pair Relationship	High Response			Low Response		
	F	S	U	F	S	U
High Stimulus						
List A + B	13.97	10.15	13.14	14.92	12.77	9.10
List A	14.17	11.09	11.83	14.30	10.73	8.63
Low Stimulus						
List A + B	17.62	16.57	12.65	18.25	14.75	8.13
List A	18.43	18.57	13.33	19.33	12.80	8.83

A P P E N D I X

Lists

	LIST A					LIST B				
High Stimulus	Response	Pair Relat.	Assoc. Value	TL Response Freq. (G)	% Formal Similarity	Response	Pair Relat.	Assoc. Value	TL Resp. Freq. G	% Formal Similarity
Belief	Relief	F	4	A	84	Judgment	S	1	A	22
Order	Arrange	S	2	A	43	Border	F	1	A	84
Glory	Story	F	1	AA	60	Renown	S	1	16	33
Leather	Chamois	S	1	1	29	Weather	F	2	AA	86
Reason	Treason	F	3	15	86	Knowledge	S	4	AA	37
Message	Notice	S	2	AA	17	Massage	F	7	3	100
Paper	Caper	F	1	7	80	Gazette	S	1	1	37
Trouble	Anguish	S	1	12	0	Turtle	F	1	13	100
Oven	Escape	U	0	AA	25	Children	U	0	AA	25
Window	Human	U	0	AA	20	Centaur	U	0	2	14
Drama	Furlong	U	0	2	14	Promice	U	0	AA	14
Shoulder	Ingot	U	0	1	20	Nomad	U	0	2	20
Low Stimulus										
Basin	Cabin	F	1	A	80	Hollow	S	1	A	0
Placard	Announce	S	1	A	25	Palace	F	3	A	84
Omen	Women	F	3	AA	60	Forecast	S	1	6	25
Arbor	Trellis	S	2	2	15	Labor	F	8	AA	80
Lorry	Dory	F	2	7	75	Wagon	S	9	A	20
Dogma	Teaching	S	5	AA	25	Sigma	F	1	8/18 mil.	60
Bramble	Gamble	F	6	16	84	Thistle	S	1	8	29
Monsoon	Delude	S	1	5	0	Mushroom	F	2	10	68
Caucus	Finger	U	0	AA	0	Visit	U	0	AA	20
Fetish	Quarter	U	0	AA	29	Knothole	U	0	1	37
Ramrod	Quibble	U	0	1	0	Island	U	0	AA	33
Skillet	Earldom	U	0	2	29	Hailstone	U	0	1	66